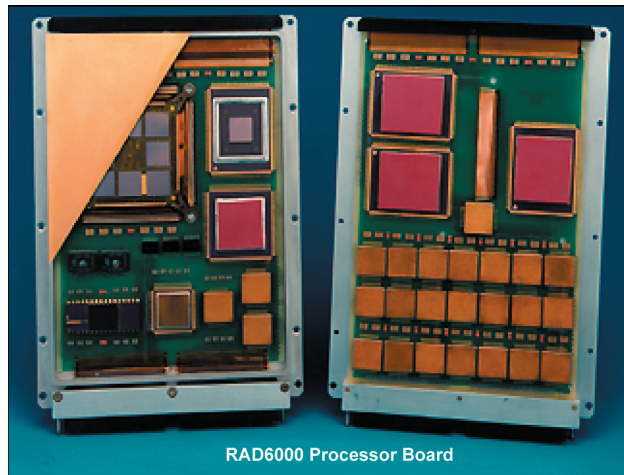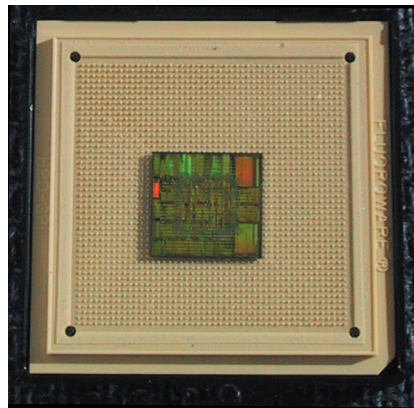# Air Force Research Laboratory | AFRL

Science and Technology for Tomorrow's Air and Space Force

Success Story

RAD6000 MICROPROCESSOR GOES BACK TO MARS

RAD6000 Processor Board

The Space Vehicles Directorate developed microprocessors that control the twin Mars robotic rovers, Spirit and Opportunity. The directorate's 32-bit microprocessor is called the RAD6000, manufactured for the Air Force by BAE Systems. The RAD6000 is now flying in approximately 100 military, scientific, and commercial satellites, and has logged years of flight time without a computer failure.

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Accomplishment

The directorate's RAD6000 is now an old hand on Mars, as it was also the main computer for the Pathfinder lander in 1997. The RAD6000 computers for the current rovers not only control the robotic vehicles on the surface, but they served as the main mission computers for the Earth to Mars mission.

A RAD6000 microprocessor is also controlling the Stardust spacecraft, which has just encountered the comet Wild 2 and will bring back samples of the comet's dust. Stardust's designers had enough confidence in the RAD6000 to use it in a single string configuration with no backup for the 7-year mission.

The RAD6000 is not only the first radiation-hardened 32-bit microprocessor. At 1.1 million transistors, it is also the most complex radiation-hardened chip ever produced and the most complex commercial component to be transferred to a hardened process. The RAD6000 is based on IBM's commercial RS/6000 microprocessor, which is a direct predecessor to today's PowerPC™ series of microprocessors.

Background

The RAD6000 chip was the world's first radiation-hardened 32-bit microprocessor, developed in 1994 by the directorate's Advanced Spaceborne Computer Module program. For military or civil space use, BAE Systems (formerly Lockheed Martin Federal Systems) had to harden the IBM RS/6000 design against the space-radiation environment. The memory elements (registers and caches) were redesigned to withstand bit upsets or flips caused by cosmic ray strikes, and the microprocessor was refabricated in BAE's radiation-hardened chip foundry for ionizing radiation hardness. Without these modifications, a commercial microprocessor would perform erratically and unreliably in space.

Space Vehicles
Technology Transfer

Additional information

To receive more information about this or other activities in the Air Force Research Laboratory, contact TECH CONNECT, AFRL/XPTC, (800) 203-6451 and you will be directed to the appropriate laboratory expert. (04-VS-13)